Development of Android-Based Augmented Reality Learning Media to Improve Learning Independence (Study on the Electric Motor Installation Subject for Class XI Students of Rejang Lebong Regency Vocational School)

Prismar[1*], Riyanto[2], Eko Risdianto[3], Muhammad Fiqih Rizqi Chandra[4], Juli Simon Macariola[5], Sm Farooque[6]

[1]SMK Negeri 1 Rejang Lebong
Bengkulu, Indonesia
[2,3]Universitas Bengkulu
Bengkulu, Indonesia
[4]International Islamic University Malaysia
Kuala Lumpur, Malaysia
[5]Philippine Christian University
Manila, Philippines
[6]Tripura University
Suryamaninagar, India
✉ boengprismar@gmail.com*

Check for updates

Abstract

The research aims to develop Android-based augmented reality (AR) media that can increase learning independence, describe the media's suitability, describe the media's practicality, and describe the effectiveness of Android-based Augmented Reality (AR) media in increasing learning independence. The scope of this research is all classes. The type of research is Research and Development approach with the ADDIE method (Analysis, Design, Development, Implementation, and Evaluation). Data collection used lifting, observation, interviews, and questionnaires. The data analysis technique is by using quantitative descriptive techniques using a Likert scale to describe trends. The research results show that at the analysis stage, learning media that is interesting, interactive, inspiring, fun, challenging, and encouraging independent learning is needed. At the design stage, Android-based AR media was created. In the development stage, media expert assessment is given very feasible criteria. Criteria subject matter expert is very worthy. Practicality tests by teachers as media users show efficient criteria. Limited scale trials obtained significant differences between the control class (quite independent) and the experimental class (independent) with student responses, strongly agreeing. In the implementation stage, significant differences were obtained between the control class (independent) and the experimental class (very independent) with student responses, strongly agreeing. The evaluation stage ensures that the media is suitable and effective for use. The conclusion is that the developed Android-based augmented reality (AR) media can increase learning independence, is suitable for use, practical in use, and effective in increasing the learning independence of class XI vocational school students in Rejang Lebong district.

A. Introduction

In the electric motor installation lesson, students are required to be able to make an electric motor control circuit properly and correctly, but in reality, students often experience difficulty in assembling the control circuit, which causes errors to occur when the circuit is connected to a voltage source. Independence is a student's attitude and behavior to regulate himself and not depend on other people. Independence, especially in learning, is very necessary so that students have responsibility in disciplining themselves. As a result of the lack of independence in learning to study learning material, many students are passive, lack attention, and tend to wait for orders from the teacher (Hidayat et al., 2020; Lestari et al., 2023; Mulyadi & Syahid, 2020).

In providing learning that is interesting, interactive, inspiring, fun, challenging, and able to provide student learning independence, the media approach used is to utilize the latest technology, namely augmented reality. Augmented reality (AR) is a technology that combines computer-generated objects, two-dimensional or three-dimensional, into the real environment around the user in real time (Garzón, 2021; Köse & Güner-Yildiz, 2021; Özçelik et al., 2022). AR is a technology that is currently being developed and implemented on smartphones (Android) that support AR. Choosing this technology, because it applies educational technology in the form of IT (information technology) learning media as one of the learning facilities in the form of smartphones (Android). The choice of learning media must be more creative, so that the media can be used optimally. The advantages of augmented reality include; helps describe abstract concepts; increasing student learning activities; make complex learning material easier to understand; presenting learning material with practical media; and the application is easy to operate (El Kabtane et al., 2020; Farshid et al., 2018; Risdianto, 2019).

This augmented reality media will be installed (installed) in the form of an Android-based application (APK), thereby providing students with the freedom and experience to run and optimize the use of Android for learning. Students will take the Android home, and in planning their learning, students need to collaborate with other students, so they need to learn together. In this way, students can learn outside the classroom independently. By developing Android-based augmented reality learning media, it can increase student learning independence, so that students can learn effectively, both individually and in groups, anywhere and at any time.

One of the factors that influences independence in the learning process is the appropriate use of media in the teaching process. As explained in the background of the problem, the problems that arise can be formulated as follows, there are still few IT learning media developed by Android-based teachers both in type and quantity, there is still low student learning independence in the learning process, and students need interesting learning media, the latest, based on Android and able to encourage student learning independence.

Augmented Reality (AR) is a technology that combines two or three-dimensional virtual objects in a three-dimensional real environment, then projects these virtual objects in real time. The basic concept of augmented reality is how an object can be visualized with the Android platform, so that objects seen from the Android camera are like objects with a 3-dimensional projection (Bharath et al., 2021; Hatmojo et al., 2021; Lizati et al., 2024). Augmented reality (AR) media will be created and programmed according to the stages, such as design using certain applications and combined with other applications, so that the results obtained can be seen by students using the Android platform with minimal capacity. This product has the advantage, apart from being able to provide a real picture of the objects displayed, it is also able to attract students' interest and curiosity. Besides being able to convey the message of learning about electric motor installation, this product can also provide students with the experience of playing (games) by using Android as a visual medium, so that the use of Android can be maximized in learning.

Most students already have an Android. Android is a necessity and always interacts with students, both in learning and in communicating. The aim of this development is to continue to train skills in developing learning media capable of delivering Android-based messages, understanding the concept of electric motor installation, so as to increase student independence in learning.

Student learning independence is very important, students must be able to plan their own learning, be able to motivate themselves, utilize learning resources, be able to evaluate learning outcomes and be able to correct weaknesses found in the learning process. There is student interest in the latest technological developments where Android is a tool that cannot be separated, so one of the advantages is that students' interest in Android can be in line with its use as a learning medium, Augmented Reality (AR), is one application that can be run with the help of Android, where This media can interact directly in real time

with its users. So, researchers suspect that, with the advantages of augmented reality learning media with the Android platform, it will increase student learning independence. Therefore, in this research, research will be carried out with the title development of Android-based augmented reality media to increase learning independence (study on the subject of electric motor installation for class XI vocational school students in Rejang Lebong district).

B. Research Methods

This research is a research development (R&D) approach. This research method functions to test, develop and create certain products (Umar et al., 2023). The product to be made is a medium that will undergo testing, until it becomes a final product that can be used. The product expected from this research is Android-based augmented reality media. The approach in this research is ADDIE (Analysis, Design, Development, Implementation and Evaluation).

Population is all subjects who are targets in a study (Stratton, 2021). So, in this research, the subjects who will be the research targets are students of the electricity study program specifically for electrical power installation engineering class XI vocational school in Rejang Lebong district. The data source is students who are random from the non-population. These students were taken using the initial testing sample equation. This sample is students selected randomly by lottery. This initial sample only uses test subjects or limited trials. The research period was carried out for three months, from August to October 2023. The research location was at a vocational school in Rejang Lebong Regency which has an electrical power installation engineering study program.

Data collection is carried out to answer or respond to research problems. Data collection techniques are very important so that the data obtained is valid and produces valid conclusions. The instruments used in this research were interview sheets, observation sheets, and product assessment sheets. The questionnaire was prepared using a Likert scale with five choices. The choice of a four-choice Likert scale has more complete or better response variability than a three-choice Likert scale, so it is able to reveal differences in respondents' attitudes more fully. In addition, the four-choice Likert scale does not provide a neutral choice so that respondents will determine their attitude towards the statement firmly. Thus, the expected result is consistency in choices and no doubts about choices.

The data analysis technique used in this research is quantitative descriptive analysis technique. This technique is used to process data obtained from questionnaires in the form of expert validation questionnaires and trial questionnaires in descriptive form. Apart from that, a questionnaire was also used to collect response data from the respondents sampled in this research.

Instruments are used to measure the value of the variables to be studied. Each instrument must have a scale to produce accurate data. The instruments used in this research mostly use instruments with a Likert scale. The Likert scale develops an attitude scale which is behavior and describes tendencies. A Likert scale with four or five variations of answers is the scale used in this research. The Likert scale was chosen because it can measure a person's attitudes, opinions and perceptions. In assessing the respondents' answers, the questions or statements listed on the questionnaire are given a score.

Several assessment scales such as the following will be given assessment criteria on a Likert scale with several assessment variants as follows.

1. The assessment criteria on a Likert scale are as in Table 1 below.

Table 1. Statement Answer Scores (Firdaus et al., 2022)

Answer Choices	Score
Strongly Agree/Very Suitable	4
Agree/Suitable	3
Disagree/Not Appropriate	2
Strongly Disagree/Strongly Disagree	1

Meanwhile, to find out the score from the results of the statement answers, the percentage of the score will be given. The percentage score will be given several criteria statements. The statement score classification will be given according to Table 2 below.

Table 2. Classification of Statement Scores (Kusumah & Risdianto, 2022)

No	Percentage	Statement Category
1	0 – 25 %	Strongly Disagree

No	Percentage	Statement Category
2	>25 – 50 %	Don't agree
3	>50 – 75 %	Agree
4	>75 – 100%	Strongly agree

2. To calculate the feasibility of augmented reality media created by material experts, media experts and student responses, the following formula is used.

$$\bar{X} = \frac{\sum x}{\sum n}$$

Information:

$\bar{X}$ = average score

ΣX = Total score

$\sum n$ = Number of assessors

The formula for calculating the overall score percentage can be used as in the following equation:

$$\text{Acquisition} = \frac{\text{Total Number of Respondents' Answers}}{\text{Total of Ideal Scores}} \times 100\%$$

Meanwhile, for the assessment of feasibility criteria which states that the product being developed is suitable or not suitable for use, it can be seen in the table which uses a Likert scale as a guide to the categories being assessed. As presented in Table 3 below.

Table 3. Eligibility percentage scale
(Sugiyono, 2021) in (Putri et al., 2023)

No	Percentage	Eligibility category
1	0 – 25 %	Not really worth it
2	>25 – 50 %	Not feasible
3	>50 – 75 %	Worthy
4	>75 – 100%	Very worthy

To analyze data on student learning independence by determining the number of scores obtained by each student first, the total scores obtained are divided by the maximum score on the questionnaire at a percentage of 100%.

3. To determine the practicality assessment, you can use the following formula. Answer Score with the following criteria:

1= Very Impractical
2= Not Practical
3= Practical
4= Very Practical

The maximum score for each practicality item is 4. The practicality score is given using the following formula.

$$\%\text{Practicality} = \frac{\text{Total Value}}{\text{Maximum Value}} \times 100\%$$

(Purwanto, 201) in (Harahap et al., 2022)

Meanwhile, to classify the practicality calculation results, they will be given as in Table 4 below.

Table 4. Classification of Practicality Levels

No	Achievement Interval (%)	Classification
1	81 – 100 %	Very Practical
2	61 – 80 %	Practical
3	41 – 60 %	Less Practical
4	21 – 40 %	Impractical
5	0 – 20 %	Very Impractical

4. To determine the percentage of student learning independence, the equation as given as follows is used.

$$\text{Acquisition value} = \frac{\text{Number of Scores Obtained}}{\text{Maximum Total Score}} \times 100\%$$

Following the results of the acquisition value, it is necessary to assign a category or determine the percentage scale. The percentage of scores obtained is interpreted based on the criteria for student learning independence scores as in Table 5 below.

Table 5. Learning independence questionnaire assessment criteria

No	Percentage (%)	Independence category
1	0 – 20%	Not Independent
2	>21 – 40%	Less Independent
3	>41 – 60%	Quite Independent
4	>61 – 80%	Independent
5	>81 – 100%	Very Independent

5. Limited Scale and Wide Scale Field Trials

The equation used to obtain media effectiveness is to use the t distribution equation. The t distribution is for the probability of small sample sizes (≤ 30). The formula used for the t-test on the effectiveness of learning independence test is:

$$t = \frac{|\bar{x}_1 - \bar{x}_2|}{\sqrt{\frac{JK_1 + JK_2}{n_1 + n_2 - 2}\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

Information:

t = Significance value

$\bar{X}_1$ = Average X1

$\bar{X}_2$ = Average X2

Jk1 = Sum of squares value 1

Jk2 = Value of the sum of squares 2

N = number of samples

The t-calculated value was compared with the t-table according to the subjects who were research respondents at the significance level of 0.05 and 0.01. if t table $\leq$ t-count then the media is effective and if t-table $\geq$ t-count then it is not effective. This t test is also intended to answer the hypothesis in this research.

This Android-based augmented reality learning media development research has several limitations, namely:

1. Limited number of schools as research targets.
2. There are limited resources.
3. References and research sources.

C. Results and Discussion

Analysis Stage

a. Needs Analysis

Several factors that become problems in learning the control components of electric motor installations in the classroom are:

1) Learning media that provides information and approaches to industries that use electric motor control components.
2) Learning approach that uses IT-based media (technology information).

Apart from conducting several discussions and interviews, the researcher also distributed a needs analysis questionnaire to students who were the target of media development. From the questionnaire distributed, it

can be concluded that students need IT-based learning media using Android, making it easier for students to learn. Especially on the subject of electric motor installation and electric motor control components.
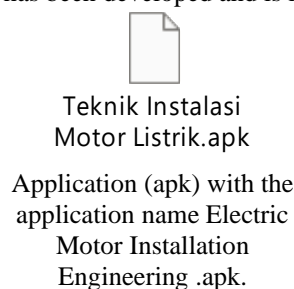
b. Curriculum Analysis
c. Characteristic Analysis

Design Stage

a. Formulating Learning Materials
b. Media Design Preparation
c. Develop research instruments
d. Create Storyboards
e. Collect references

Development Stage

a. Results of AR media development

At this stage, augmented reality media has been developed and is in the form of a program

Teknik Instalasi
Motor Listrik.apk

Application (apk) with the
application name Electric
Motor Installation
Engineering .apk.

Figure 1. AR Application Icon

This application is stored on Google Drive complete with marker. All contents of this program can be downloaded using the following QR code. By scanning this QR Code, users will be guided to download and install the *.apk program.

b. AR Media Validation Results

1) Media Validation Results

The media expert validation assessment sheet includes four aspects and 18 indicators. These four aspects are: 1) The display aspect consists of 4 indicators; 2) The ease of use aspect consists of 3 indicators; 3) The learning aspect consists of 7 indicators, and 4) The Augmented reality aspect consists of 4 indicators.

The results obtained information about the validity of augmented reality (AR) learning media with a total final score of 71.3, with an average score of 3.96. If this value is converted to a percentage, the final media validation value is 99.07% (percentage range >75 – 100%), which is in the feasibility category, namely very feasible (SL).

2) Material Validation Results on AR Media

Material expert validation assessment sheet on learning media, covering four aspects and 18 indicators. The four aspects are: 1) The content aspect of the learning material consists of 5 indicators; 2) The language aspect used consists of 4 indicators; 3) The presentation aspect of learning material consists of 5 indicators, and 4) The benefit aspect of learning material consists of 4 indicators.

The results obtained were information about the validity of the material in augmented reality (AR) learning media with a total final score of 71.0, with an average score of 3.94. If this value is converted to a percentage, the final material validation value is 98.61% (percentage range >75 – 100%), which is in the feasibility category, namely very feasible (SL).

c. Results of AR Media Practicality

The practicality obtained contains information about the practicality test results given by reviewers on augmented reality (AR) learning media with a total final score of 78.5, with an average score of 3.93. If this value is converted to a percentage, the final media practicality value is 98.13% (percentage range > 81 – 100%), which is in the classification of very practical.

d. Limited Scale Trial

The classes that will be used are the control class and the experimental class in limited scale field trials. The determination of the control class and experimental class was carried out in a random manner, with the results of the researcher using class XI Electrical Power Installation Engineering 2 which the researcher divided into 2 groups randomly. One group was used as the control class (class A) and the other group was used as the experimental class (class B).

These two classes were not treated with learning at the same time, each class (A and B) had separate classrooms and learning times. Where class A is in the electric motor installation practice room and class B is in the computer room, so that these two groups do not know the form of treatment given by the teacher who teaches.

In the results of the limited scale test, data was obtained that there were ten respondents in each group. Group A is the control class, and group B is the experimental class. These two classes have been given two different treatments, where in class A, the usual method is given, while in class B the augmented reality learning media is given. The results shown show that Ms. AP as observer 1, and Ms. SAU as observer 2, show that the control class has an average independence score of 52.8%, in the range >41 – 60% in the Self-Independent category. Meanwhile, the experimental class has an average score of 68.5%, in the range >61 – 80% in the Independent Independence category.

e. Media Effectiveness Test

1) Results of t test analysis

The t test is a form of testing that can provide information about the significance of differences between two data (2-tiled).

Results of t test analysis with Ms Excell

$$
\begin{aligned}
\text{Numerator} &= 15.6818 \\
\text{Denominator} &= 1.0177 \\
t &= 15.5450 \\
db &= 18 \\
p &= 0,000 \\
t\ 0.05\ \text{(table)} &= 1,682\ \text{(One-Tailed Test)}
\end{aligned}
$$

There is a significant difference between the Class A average and the Class average

t table < t count= B

Significant (Effective) Media to increase student learning independence

Result of t test with IBM SPSS version 25

Using the SPSS application, the data that will be used is the same as the data used in the analysis using Microsoft Excel.

Table 6. Limited Scale t Test Results

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
| | | | | | | | | | 95% Confidence Interval of the Difference | |
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Learning Independence Test Results	Equal variances assumed	,032	,861	-15,539	18	,000	-19,62000	22,27277	-15,18340	-16,96723

Independent Samples Test

Equal variances not assumed	-15,539	17,813	,000	-19,62000	22,27476	-15,18720	-16,96524

The results of the t test analysis in table 1 above show that the t value of 0.05 (table) is 1.682. Meanwhile, the t (calculated) value was 15.53. This means that the value of t (table) < t (calculate), if so, then this result shows that there is a significant difference between class A and class B. Apart from being seen from the calculation above, this result can also be seen from the magnitude of the Sig value. (2-tiled), if the Sig value <0.05, from the calculation results table with SPSS, the Sig value is obtained. of 0.000, meaning this result shows that this media is effective in increasing learning independence between class A (control) and class B (experiment).

f. Limited Scale Media Assessment Response Results

Android-based augmented reality learning media is applied to classroom learning at the limited trial stage, students are asked to fill in a student response sheet regarding the quality of the learning media. This aims to find out how much students agree with the media developed by researchers. The results of the assessment were completed by 10 students in the limited scale experimental class. The assessment sheet on how students agree with receiving the Android-based augmented reality learning media that they have tried to operate, consists of 15 indicators consisting of three assessment aspects, namely; 1) Display aspect; 2) Ease of use aspect, and 3) Learning aspect. The total results of student responses to learning media obtained a score of 92.33% (>75 – 100%) with the strongly agree category.
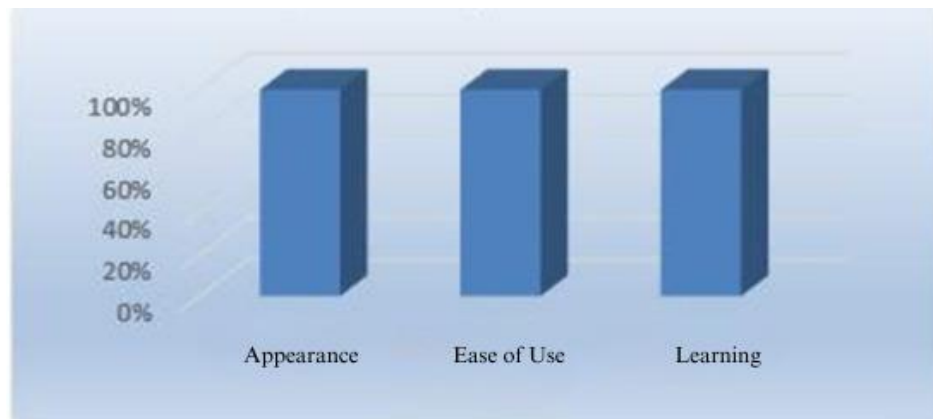
Figure 1. Graph of Student Response Results in Limited Scale Trials

Judging from the students' responses to the learning media being developed, the average shows that they strongly agree with the media being developed. In the appearance aspect, an average score of 87.5% was obtained in the range >75 – 100% with the strongly agree category. The ease of use aspect obtained an average value of 95.8% in the range >75 - 100% with the strongly agree category. And the learning aspect obtained an average score of 94.3% in the range >75 – 100% with the strongly agree category.

Implementation Stage

a. Learning Independence Results

After carrying out the testing process on a wide scale, several results were obtained which are a picture of the effectiveness of Android-based augmented reality learning media. Testing the effectiveness of the learning media involves two classes, namely the control class using a student worksheet on installing a normal electric motor and a student worksheet that guides the use of an Android-based augmented reality application.

In class A, the final result obtained was 68.7 in the independent category (in the range > 61 – 80%). If you look at students in the vocational school age range, on average they are already independent. Meanwhile, in class B column, the final result obtained was 82.7 in the very independent category (in the range >81 – 100).

b. Media Effectiveness Test Results

The test that the researcher carried out was with the help of Microsoft Excel and SPSS 25. These two applications must give the same results. So, with these two results, some conclusions and answers to hypotheses in the research will be more reliable.

Table 7. T test results with Microsoft Excel

Respondent No	Independence Observation Results		Note.
	Class A	**Class B**	
n	20	20	
∑X	1367.73	1648.18	
∑X2	93575.00	135906.20	
JK	41.11	81.03	
rt-2	68.39	82.41	

Table 8. t test results using SPSS

		Levene's Test for Equality of Variances		t-test for Equality of Means						
Independent Samples Test										
									95% Confidence Interval of the Difference	
		F	**Sig.**	**t**	**df**	**Sig. (2-tailed)**	**Mean Difference**	**Std. Error Difference**	**Lower**	**Upper**
Hasil Uji Kemandirian Belajar	Equal variances assumed	1,009	,321	-24,858	38	,000	-14,04000	,56481	-15,18340	-12,89660
	Equal variances not assumed			-24,858	34,515	,000	-14,04000	,56481	-15,18720	-12,89280

The results of the t test analysis in table 3 above show that the t value of 0.05 (table) is 1.682. Meanwhile, the t (calculated) value was 24.85. This means that the value of t (table) < t (calculate), if so, then this result shows that there is a significant difference between class A and class B.

Apart from being able to be seen from the calculation above, this result can also be seen from the large Sig value. (2-tiled), if the Sig value <0.05, from the calculation results table with SPSS, the Sig value is obtained. of 0.000, meaning this result shows that this media is effective in increasing learning independence between class A (control) and class B (experiment).

c. Wide Scale Media Assessment Response Results

The results of the assessment have been completed by 20 students in the large-scale experimental class as shown in the attachment. The assessment sheet on how students agree with receiving the Android-based augmented reality learning media that they have tried to operate, consists of 15 indicators consisting of three assessment aspects, namely; 1) Display aspect; 2) Ease of use aspect, and 3) Learning aspect. The total results of student responses to learning media obtained a score of 87.50% (>75 – 100%) with the strongly agree category.

Figure 2. Graph of Student Response Results in Wide-Scale Trials

Judging from the students' responses to the learning media being developed, the average shows that they strongly agree with the media being developed. In the appearance aspect, an average score of 85.0% was obtained in the range >75 – 100% with the strongly agree category.

The ease of use aspect obtained an average value of 90.4% in the range >75 - 100% with the strongly agree category. And the learning aspect obtained an average score of 88.0% in the range >75 – 100% with the strongly agree category.

Evaluation Stage

The final stage of this research using the ADDIE model is the evaluation or assessment stage. After the Android-based augmented reality learning media has been implemented, the next stage is to perfect the learning media. At each stage in which learning media development is carried out, it is hoped that it will obtain the best quality and maximum usefulness.

The results of the development of Android-based augmented reality learning media using the ADDIE development model can be assessed that the Android-based augmented reality learning media developed is very suitable for use as an effective learning media to increase the learning independence of class XI vocational school students in Rejang Lebong Regency.

1) Developed Android-Based Augmented Reality Learning Media Can Increase Learning Independence

Android-based augmented reality learning media has been developed and is able to show significant differences between the control group and the experimental group. Both in limited scale tests and in wide scale tests, in increasing student learning independence. If this type of learning media is developed further, in accordance with the suggestions, then media like this will encourage students to be more independent in their learning.

From the theory and research results, it can be concluded that Android-based augmented reality learning media can increase the learning independence of class With this AR learning media, student learning independence will increase.

2) The Android-Based Augmented Reality Learning Media Developed is Suitable for Increasing Learning Independence

Ekayogi (2023:182) proves that the application of the problem based learning model with the help of augmented reality can improve learning outcomes and student learning independence. If this Android-based augmented reality learning media can be easily responded to by students and easily adapted to their technological capabilities, then this learning independence will increase.

Augmented reality learning media is able to create an interesting and enjoyable learning atmosphere (Kusumo, et al. 2021:10). During the experiment process, students were very enthusiastic. If you look at the comments and suggestions, almost all respondents were happy and very interested in learning media. On the suggestion side, almost all students want quizzes as a means of practice on this media to increase the number of questions.

Augmented reality-based learning is included in the category that is very suitable for use. This is supported by the fact that the development of augmented reality technology for productive subjects in vocational schools can meet the need to increase students' understanding of complex material. Making learning easier will shape students' ability not to depend on other people so that students will be encouraged to be independent in their learning (Widuroyekti, 2022:10).

3) Practical Android-Based Augmented Reality Learning Media Used to Increase Learning Independence

The results of research conducted by Cindy Febyola, et al (2021) state that the augmented reality learning media applied to electric motor installation subjects has very practical practical value. In this research, practicality aims to see how practical augmented reality learning media is, taken from the assessments of teachers who will use this learning media as a learning resource.

4) Android-Based Augmented Reality Learning Media is Effectively Used to Increase Learning Independence

Khoirudin, et al (2020) stated that augmented reality learning on the Android platform makes it easier for students to learn. Students are interested and it is fun to learn. Not only attracted by the appearance, but also helps students to be independent in learning. Based on the research results described above, it can be concluded that the Android-based augmented reality learning media developed is very effective in increasing the learning independence of class XI students in electrical power installation engineering, where this learning media is very flexible in its use.

The development of Android-based augmented reality learning media has the following implications.

1) Android-based augmented reality learning media can help students to better understand learning material, apart from being given visualizations like real objects, students are also taken to see 3-dimensional views and interesting animations.
2) Android-based augmented reality learning media, apart from being a learning tool and medium, can also maximize Android's function as a learning medium. And this learning media can be taken home. This media is quite complete. Apart from having visualization of 3-dimensional objects, animations, learning materials and quite challenging quizzes. This will encourage faster independent learning.
3) This Android-based augmented reality learning media is also a medium that can be used jointly by students as users. Collaboration in learning, cooperation that encourages mutual learning independence. Several mysteries need to be solved by students, curiosity arises, so that students will collaborate in exploring Android-based augmented reality learning media, until they have truly mastered this media, like a game.

There are several limitations to the Android-based augmented reality learning media that was developed, including the Android-based augmented reality that was developed more focused on the subject of electric motor installation. In fact, it can be further developed for other subjects, both vocational and non-vocational subjects at all levels of education. In applying this augmented reality learning media, many aspects of programming will be discovered, so for other researchers who are interested in continuing or starting new, must really have the ability to process 3-dimensional programs, or at least understand the programming steps. For future researchers, the development of Android-based augmented reality media should be further developed, more innovative, and with more animations. As a suggestion, some of the basic programs used in this research are Blender 3D animation, Vuforia, Unity 3D, and others.

D. Conclusion

Android-based augmented reality learning media can be developed according to existing theories so that it helps students easily understand and learn subject matter and can increase learning independence. With independent learning, a student can solve problems related to his studies without depending on the teacher or his classmates. The use of IT-based learning media such as augmented reality will encourage student learning independence. Android-based augmented reality learning media is very feasible for increasing student learning independence based on the validation results of media experts and material experts so that it is recognized as very feasible. The practicality of Android-based augmented reality learning media is designed based on Android design. Media can be used and operated anytime, anywhere. Learning media can be run without using internet data packages, so this media is very practical. The effectiveness of the Android-based augmented reality learning media developed can increase the learning independence of class XI students. Electrical power installation techniques at Rejang Lebong Vocational School can increase learning independence.

References

Bharath, G., Rupa, C., Karthik, M., Leela Bhavani, A., & Manish Chowdary, V. (2021). Revelation of Geospatial Information using Augmented Reality. *2021 International Conference on Wireless Communications, Signal Processing and Networking, WiSPNET 2021*, 303–308. https://doi.org/10.1109/WiSPNET51692.2021.9419459

El Kabtane, H., El Adnani, M., Sadgal, M., & Mourdi, Y. (2020). Virtual reality and augmented reality at the service of increasing interactivity in MOOCs. *Education and Information Technologies*, *25*(4), 2871–2897. https://doi.org/10.1007/s10639-019-10054-w

Farshid, M., Paschen, J., Eriksson, T., & Kietzmann, J. (2018). Go boldly!: Explore augmented reality (AR), virtual reality (VR), and mixed reality (MR) for business. *Business Horizons*, *61*(5), 657–663. https://doi.org/10.1016/j.bushor.2018.05.009

Firdaus, F., Wahyuni, S. T., & Risdianto, E. (2022). Response about the Importance of Digital Marketing Skills for Vocational Teachers. *JENTIK : Jurnal Pendidikan Teknologi Informasi Dan Komunikasi*, *1*(1), 1–5. https://doi.org/10.58723/jentik.v1i1.34

Garzón, J. (2021). An Overview of Twenty-Five Years of Augmented Reality in Education. *Multimodal Technologies and Interaction*, *5*(7), 1–14. https://doi.org/10.3390/mti5070037

Harahap, M., Mujib, A., & Nasution, S. A. (2022). Pengembangan media uno math untuk mengukur pemahaman konsep luas bangun datar. *Jurnal All Fields of Science J-LAS*, *2*(1), 209–217. https://doi.org/10.58939/afosj-las.v2i1.158

Hatmojo, Y. I., Maryadi, T. H. T., Badarudin, R., & Indrawati, B. (2021). Mobile Augmented Reality Application for Component Identification. *Journal of Physics: Conference Series*, *2111*, 1–8. https://doi.org/10.1088/1742-6596/2111/1/012039

Hidayat, D. R., Rohaya, A., Nadine, F., & Ramadhan, H. (2020). Independent Learning of Students in Online Learning During The Covid-19 Pandemic. *Perspektif Ilmu Pendidikan*, *34*(2), 147–154. https://doi.org/10.21009/PIP.342.9

Köse, H., & Güner-Yildiz, N. (2021). Augmented reality (AR) as a learning material in special needs education. *Education and Information Technologies*, *26*(2), 1921–1936. https://doi.org/10.1007/s10639-020-10326-w

Kusumah, R. G. T., & Risdianto, E. (2022). Analysis of Training Participants' Responses to Training Activities with the Theme "ICT-Based Innovative Learning." *JENTIK : Jurnal Pendidikan Teknologi Informasi Dan Komunikasi*, *1*(1), 19–24. https://doi.org/10.58723/jentik.v1i1.37

Lestari, N. P., Khosiyono, B. H. C., Cahyani, B. H., & Nisa, A. F. (2023). Analisis Penerapan P5 Untuk Pembentukan Karakter Mandiri Pada Siswa Sd. *Pendas : Jurnal Ilmiah Pendidikan Dasar*, *08*(03), 4091–4097. https://doi.org/10.23969/jp.v8i3.10870

Lizati, F., Kumajas, S. C., & Sangkop, F. I. (2024). Application of Augmented Reality in Mobile Based Hijaiyah Letter Recognition Applications Using Multimedia Development Methods Life Cycle. *Journal of Innovation And Future Technology (IFTECH)*, *6*(1), 84–95. https://doi.org/10.47080/iftech.v6i1.3131

Mulyadi, M., & Syahid, A. (2020). Faktor Pembentuk dari Kemandirian Belajar Siswa. *Al-Liqo: Jurnal Pendidikan Islam*, *5*(02), 197–214. https://doi.org/10.46963/alliqo.v5i02.246

Özçelik, N. P., Ekşi, G. Y., & Baturay, M. H. (2022). Augmented Reality (AR) in Language Learning : A Principled Review of 2017-2021. *Participatory Educational Research*, *9*(4), 131–152. https://doi.org/10.17275/per.22.83.9.4

Putri, N. A., Hermanto, F., Irianna, O., Dewangga, P. A., Prasetya, H., & Nisa, N. (2023). Pengembangan Media Pembelajaran Katalog IPS berbasis Potensi Lokal di Kabupaten Semarang. *Harmony: Jurnal*

Pembelajaran IPS Dan PKN, *8*(2), 112–122. https://doi.org/10.15294/harmony.v8i2.61930

Risdianto, E. (2019). Development of Blended Learning Based on Web and Augmented Reality. *1st International Conference on Educational Sciences and Teacher Profession (ICETeP 2018)*, *295*, 144–147. https://doi.org/10.2991/icetep-18.2019.35

Stratton, S. J. (2021). Population Research: Convenience Sampling Strategies. *Prehospital and Disaster Medicine*, *36*(4), 373–374. https://doi.org/10.1017/S1049023X21000649

Umar, U., Purwanto, M. B., & Al Firdaus, M. M. (2023). Research and Development: As the Primary Alternative To Educational Research Design Frameworks. *JELL (Journal of English Language and Literature) STIBA-IEC Jakarta*, *8*(01), 73–82. https://doi.org/10.37110/jell.v8i01.172